ROYAL COLLEGE OF SURGEONS IN LONDON

to The Library of the Royal College of Surgeon From the Author.

XXXVIII.—*On the Existence of Branchiæ in the young* Cæciliæ; *and on a Modification and Extension of the Branchial Classification of the* Amphibia*. By John Hogg, Esq., M.A., F.R.S., F.L.S., F.C.P.S., &c.

Looking over, in November last, the volume of the 'Comptes Rendus' of the meetings of the Academy of Sciences at Paris for the year 1839, I came to the report of a paper entitled, "Notice historique sur la place assignée aux *Cécilies* dans la série zoologique, par M. de Blainville," in which (No. 22, at p. 673) I read the passage which I have thus translated:—"In the mean time, in 1836, on the opportunity of describing some reptiles which were brought from California by M. P. E. Botta, I gave a characterized analysis of my system of Herpetology and Amphibiology, and I supported the place that I had assigned to the *Cæcilia* by the curious fact observed by Prof. Müller of a young *Cæcilia* in the Museum at Leyden, which was furnished with *branchial apertures*.

"1839. Although this fact appears not to have been known, any more than, without a doubt, my own labours on this subject were, to Mr. John Hogg, who has just published a long memoir on the Classification of the Amphibia in Mr. Charlesworth's 'Magazine of Nat. Hist.' for June [and concluded in the August Number] 1839, it will be there seen that he has also arrived at the same conclusion with us; that is to say, of making a distinct class of the Batrachians under the name of *Amphibia*, and a separate order of the *Cæciliæ* under the new denomination of *Abranchia*, because he has selected for his principal consideration the organs of respiration: only that he places them at the commencement, in order to connect them with the *Ophidians*, instead of terminating the class by them*."

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* [This communication, in its original state, was received by the Editors in the middle of February; but they retained it until the author's return to London, in order to direct his attention to the papers on the *Lepidosiren* by M. Milne Edwards and Sir W. Jardine.—Ed.]

Here it was that I received the first intimation of Prof. J. Müller's discovery of *branchial apertures* in a young *Cæcilia*; and on a further perusal, I found that this historical notice by M. de Blainville was both in answer to, and continuation of, M. Duméril's 'Mémoire sur la classification et la structure des Ophiosomes ou Céciloïdes, famille de Reptiles qui participent des Ophidiens et des Batraciens, rélativement à la forme et à l'organisation,' which had been read at a previous meeting of the Academy, and the report of which is inserted in a former number (20) of the same volume of the 'Comptes Rendus' (p. 581).

M. Duméril has given a brief description of this highly interesting discovery; but as this is abridged from a *part* only of Prof. J. Müller's own account as published in Oken's 'Isis' for 1831, p. 710, and supposing that the whole of so distinguished an anatomist's paper on the subject—which also comprises his classification of the *Amphibia*—will be received with satisfaction, since it is published in a foreign work not frequently to be met with in England, I make no apology for giving a translation of the whole from the original German.

"Branchial apertures discovered in a young *Cæcilia hypocyanea*, in the Museum of Natural History at Leyden, by Prof. John Müller.

"In the spring of the year 1831 I visited the great Museum of Zoology and Anatomy at Leyden, where the particular kindness of MM. Temminck, Van der Hoeven, Sandifort, Brörs, Schlegel, and Dr. Haan, made my short stay highly profitable and useful. On an examination of the *Cæciliæ* which are preserved in that exceedingly rich Museum of Natural History, I discovered, in quite a young *Cæcilia hypocyanea*, upon each side of the neck, some lines from the extremity of the fissure of the mouth, an aperture a line in length. This opening is in length somewhat more than in height; it is placed in the yellow band which marks the sides of the *Cæcilia hypocyanea*, and this yellow band is just there much wider. The edge of the aperture is sharp; in its interior black fringes were visible, which appear fixed to the horns of the tongue-bones or branchial arcs, but they did not project out of the aperture. The apertures themselves continue in more open communication with the cavity of the mouth. This young *Cæcilia*, which, being the only specimen, could not be dissected, measured 4½ inches in length; whilst a full-grown specimen of the same species, that exhibited no vestige of these apertures, was more than a foot long.

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* Comptes Rendus des Séances de l'Académie des Sciences, tom. ix. No 22. 2e Semestre, 1839.

"It is therefore now ascertained, that the *Cæciliæ,* which have so many anatomical resemblances with the naked Amphibians, really belong to them, and that they undergo metamorphosis. They likewise resemble in external structure the *Amphiumæ,* which, with a vermiform shape of the body, retain their gill-apertures during life, without the branchiæ remaining. The division of the *Batrachians* is too confined and defective. All the *scaled* or *shielded Amphibians* (the Crocodiles, Lizards, Serpents and Tortoises) have as common characters—one distinct penis or two, a double cloaca, two orifices in the organ of hearing, and a cochlea. These must constitute one division. All the *naked Amphibians,* on the contrary, have no penis, a single cloaca, only one orifice, and no cochlea in the ear. All the *Amphibia nuda* possess either early gills, later lungs, or both during the whole of life. The orders of the *Amphibia nuda* are as follow:—

"I. *Gymnophidia* seu *Cæciliæ.* Without feet, branchial apertures in the young state.

"II. *Derotremata,* from δερη, *neck,* and τρημα, *aperture.* Four rudimentary feet. Apertures in the neck throughout life without branchiæ. Here belong the *Amphiuma* and *Menopoma.*

"III. *Proteidea.* Gills and lungs through the whole of life. *Proteus, Axolotl, Menobranchus, Siren.*

"IV. *Salamandrina.*

"V. *Batrachia.*

"Messrs. Schlegel and Van der Hoeven will gladly testify the accuracy of the before-mentioned assertion concerning the *branchial apertures* of the young *Cæcilia.* This animal remains preserved in the Museum at Leyden. The anatomy of the *Cæcilia lumbricalis,* and many of the doubtful or anomalous Serpents, I have described in a separate paper that appeared in Meckel's 'Archives.' I will communicate in a supplement thereto, a drawing of the young *Cæcilia hypocyanea* with its gill-apertures. I have there also endeavoured to place the distribution of the anomalous and true Serpents upon anatomical grounds; and the arrangement of the *naked Amphibians,* except the second principal division of the *Amphibia* in the five orders above given, is accurately made from full anatomical examinations. These orders of the *Amphibia nuda* are proposed according to the form of the animals, which are there just so separated as the Serpents, Lizards, Crocodiles, and Tortoises are in the division of the *Amphibia squamata*."

Now the species of *Cæcilia* there described by Prof. J. Müller is the *C. hypocyanea* of Van Hasselt, which was so named on account of its pale *blue* colour along the *under* part of its body; it is synonymous with what Linnæus names *C. glutinosa*, and what Wagler calls *Epicrium Hasseltii*, and is a native of Ceylon as well as Java.

But it is remarkable that, although nearly ten years have transpired since this discovery took place, no mention is made of it in any English work on Natural History* with which I am acquainted; *except* indeed in Dr. Grant's last Part (VI.) of his 'Outlines of Comparative Anatomy,' published in the latter part of 1840, where (at p. 551) he has given an extremely short notice of it under the head of 'Organs of Respiration.'

The *presence* of branchiæ then, in the *Cæcilia* in its young state, obliges me to modify, in some degree, the classification which I had instituted four years ago for the *Amphibia*, and which is given in the 'Magazine of Natural History,' new series, vol. iii. pp. 265, 367. For this purpose, my Order I. *Abranchia* must be entirely removed, since it is now clearly proved that every genus of the *Amphibia* is furnished, either at the first period of existence with some kind of branchial apparatus which is afterwards exchanged for a pulmonary one, or else with both sorts of apparatus during the entirety of life.

The late discovery of Müller has decided—what indeed the appearance of the hyoïd bones in the adult *Cæcilians* had given reason previously to suspect—namely, the former existence of branchial apertures with gills or branchial fringes, and a subsequent metamorphosis as to these organs, in the *Cæciliadæ*†. Wherefore the true place to be assigned to this family in the branchial classification is, among the *Caducibranchia*, or those *Amphibia* whose gills *decay* at an early period; although from that able Professor's description it appears that the *gills* themselves, or the *fringes*, are *concealed within* the branchial apertures, and do not hang out of, or project from, those apertures, as they do in the other families of the *Caducibranchia*.

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* I fully expected to have seen these *branchiæ* described in the account of the *Cæcilians* at p. 285 of Cuvier's 'Animal Kingdom,' translated by Messrs. Blyth, Mudie, Johnston and Westwood, particularly as its preface says—"the present edition embodies *all* the discoveries of more recent naturalists," and which has only just been published; but I was disappointed.

† See my paper in Mag. Nat. Hist., vol. iii. N. S. p. 368.

It then becomes necessary so to separate them into *two* distinct tribes:—the *first* of which I name *Celatibranchia,* signifying the *gill-fringes concealed*; and the *second* I designate by the term *Prolatibranchia,* i. e. having the *gill-tufts exposed.* Nevertheless, much still remains to be investigated with respect to the early mode of life, aquatic respiration, development of the lungs, and changes in the circulatory organs of the *Cæcilians.*

In Prof. Müller's arrangement given above, the *Cæciliæ* are classed in the *first* order of his *Amphibia nuda* under the name of *Gymnophidia,* or *Naked Serpents*; though I must observe, that this name cannot be strictly applied to these *snake-like* Amphibians, because they are in reality not altogether *naked,* being furnished with numerous *small scales.*

M. Duméril also says in his Memoir*, that M. Bibron and himself have determined, "in the eighth volume of the 'Natural History of Reptiles,' which is now printing, to establish amongst the *Batrachians,* and under the name of *Péromèles,* a first sub-order comprising all the genera that are without *legs.* These are four in number, and compose a family which we call *Ophiosomes* or *Céciloïdes,* because these appellations will remind us of their resemblance to the Serpents, and at the same time will recall the principal genus—the most numerous in species—which is distinguished as the first by the name of *Cæcilia.*"

However, I may here remark, that this sub-order of *Péromèles,* derived from πηρος, *wanting,* and μελος, *limb* or *leg,* is merely synonymous with Oppel's family *Apoda,* which he formed in 1811 for the genus *Cæcilia,* although previously given by Linnæus to an order of Fishes, and which has been subsequently adopted by several zoologists. But in what order or family M. de Blainville has recently placed the *Cæciliæ* in his system of Amphibiology, given in 1836 in his description of reptiles brought from California by M. Botta, I cannot ascertain, not having seen the work itself, but only the passage in the historical notice, before cited, from the 'Comptes Rendus,' p. 673. Yet I am much gratified in learning that M. de Blainville agrees with me in making the *Batrachians* (of the French naturalists) constitute a distinct class under the name of *Amphibia,* and not merely the *fourth* order of the class *Reptilia,* according to the old arrangement of M. Brongniart and his followers, as MM. Daudin, Duméril, Cuvier, etc.

Again, I think a further modification is requisite in my previous classification, which is, to separate the Toads from the Frogs (*Ranidæ*), and to place them, as Prof. Bell has done, in *another* family, *Bufonidæ*[*]; one of the chief distinctions of the latter being the *absence of teeth.*

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* Comptes Rendus, 1839, tom. ix. No. 20. p. 583.

Next, the late discovery of a very remarkable and anomalous animal renders an extension of my proposed classification very necessary;—the animal which I mean is what Fitzinger[†] and Natterer[‡] denominate "Lepidosiren," and consider as forming a new genus of the fish-like *Amphibians*, whilst Prof. Owen[§] regards it, with another species, as being more nearly allied to the *Fishes*. And I may remark that the *L. paradoxa*, a native of the marshes near the Amazon, in South America, where it is named Caramuru, is extremely like the *Siren* in general character and form; whilst the *L. annectens*, which inhabits the river Gambia in Africa, more resembles in its shape the *Siredon pisciformis*, or Axolotl of Mexico. It is also used for food by the inhabitants of that part of Africa, as the Axolotl frequently is by the Mexicans.

Now the presence of distinct *lungs* in both these animals makes me at once dissent from the opinion of the latter author, and decides with me the question—whether they are to be esteemed as true *Amphibians*, or true *Fishes*?

Yet Prof. Owen has resolved this question in favour of their being *Fishes*, principally from their *nose*; which consists of two membranous sacs, plicated within, opening externally on the upper lip, but (according to his observation) without communicating with the fauces or mouth[||]. The other ichthyic characters observable in their organization I regard as of minor importance.

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[*] History of British Reptiles, p. 105.

[†] Froriep's Notizen, vol. i. p. 90; and Wiegmann's Archiv, 1837, p. 232.

[‡] *Lepidosiren paradoxa*, eine neue Gattung, aus der Familie der Fischähnlichen Reptilien, von Johann Natterer, Annalen des Wiener Museums der Naturgeschichte, 1837, vol. ii. p. 165.

[§] Description of the *Lepidosiren annectens*, Linn. Trans., vol. xviii. p. 327.

[||] M. Milne Edwards, in his paper 'On the Natural Affinities of the *Lepidosiren*' in the Ann. des Sci. Nat. for September 1840, writes as follows:—"One of the reasons upon which Mr. Owen most insists for placing the *Lepidosiren* amongst fish, is the want of communication between the nasal cavity and the mouth; but M. Bischoff asserts, that in the species which he dissected there exist hinder-nostrils (*arrière-narines*) opening into the cavity of the mouth near to the commissure of the lips. I also saw these posterior openings of the nasal cavity in the *L. paradoxa* dissected by M. Bibron, and their abnormal position appears to be in part explained by the absence of superior maxillary bones." This paper, a translation of which was given in the 'Annals and Mag. Nat. Hist.' for February 1841, p. 467, I had not seen until some time after mine was written and in the editors' hands. I must here point out that Mr. Owen made his dissection of the *L. annectens*, while MM. Bischoff and Bibron examined the *L. paradoxa*.

Thus it seems to me, that we must either account these animals as *Fishes* endowed with true and well-developed *lungs* of a vascular and cellular structure and fitted for respiring air, similar to those of the *Amphibia* and *Reptiles*, and with some other essential characters also common to the *Amphibia*; or as *Amphibians* possessing *nasal sacs* with an external orifice only (according to Mr. Owen) and adapted for smelling like those of the *Fishes*, and likewise having a few other ichthyic characters; or in fewer words, *either* as *Fishes* with the *lungs* and some other principal characters of the *Amphibia*, *or* as *Amphibians* with the *nose* and a few other inferior characters of *Fishes*.

Here, then, we must elect, whether we assume the *lungs* or the *nose* as the chief characters whereby to decide in which class of the *Vertebrata* these animals ought to be most correctly placed. However, it will be readily admitted by all naturalists, that the former or the *respiratory* organs far exceed in importance the latter or the *olfactory* organs, and therefore must compel us at once to select them for the classification of these animals in preference to the latter. And surely even by considering these animals as *Amphibians** possessing the *nose* or *nasal sac* of *Fishes*, it will be much less incongruous and much less departing from the usual and received characters of the divisions of the *Vertebrata*, than if we were to esteem them as *Fishes* furnished with the *lungs* of the *Amphibia*; for this I cannot but think would be too anomalous and too much at variance with the general definition of Fishes —as having gills but *no lungs*—notwithstanding that the air or swimming-bladders of two or three genera of Fishes of the family *Clupeidæ* somewhat approach in cellular structure to the lungs of Reptiles.

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* M. Milne Edwards has likewise stated, in the paper already quoted, *two* other characters belonging to the *L. paradoxa*, which afford strong evidence in favour of its being correctly esteemed an *Amphibian*. The *first* is, that "M. Bibron has also satisfied himself of the existence of the *two auricles* of the heart described by M. Bischoff, so that in this important respect the *Lepidosiren* stands remote from Fish and approaches nearer to most Reptiles." And the *second* is, that "the lungs of Mammalia, of Birds, and of Reptiles, as every one knows, always originate from the *ventral face* of the digestive tube, whatever their position may be in the splanchnic cavity, and it is always on the ventral side of the pharynx that the opening of the glottis is found; it is the *same* with the *Lepidosiren*."

Now if, on a more minute examination of the *L. annectens*, this animal shall be found never to possess any hinder nostrils communicating with the mouth, and that its heart has only a *single* auricle, then I think it will be necessary to consider it as a *genus* distinct from the *L. paradoxa*, and which I would name *Protomelus*. I must also add, that the *L. paradoxa* has fifty-five pairs of ribs, whilst the *L. annectens* possesses only thirty-six.

Wherefore I agree with M. Fitzinger, Dr. Natterer and Prof. Jones*, in regarding these animals as two distinct species of a new *genus*, belonging rather to the *Manentibranchious Amphibians* than to any order of Fishes.

I find also that M. Bischoff concludes, from a skilful dissection of the *L. paradoxa*, that it is an *Amphibian* and not a Fish. See his memoir published at Leipsig in 1840; also the translation of it, with five plates, in the 'Annales des Sciences Naturelles' for August and September 1840. At page 155 of the latter number, Prof. Bischoff observes, concerning the *L. paradoxa*, that its nasal cavities are perforated behind† and open into the mouth; that its heart has two auricles; that its lungs have not the character of swimming-bladders; and that the organization for the most part of its soft parts, especially of those of circulation and respiration, differ from those of Fishes. It is likewise said that this animal produces a sound resembling the cry of a cat. Again, as it is evident, the name "Lepidosiren," signifying a *Scaly Siren*, which was given by M. Fitzinger to this genus, is not altogether appropriate, since it would lead us to conclude that this is the *only* Amphibian possessing *scales*, whereas the *Cæciliæ*, as it is well known, are likewise furnished with small *scales*. And Prof. Owen says, at p. 332 of the Linn. Trans., vol. xviii., that he recorded, in the *MS.* Catalogue of the Museum of the Royal College of Surgeons in London, the *Lepidosiren* under the name of '*Protopterus*'—doubtless derived from πρωτος, *first*, and πτερον, *fin*—to express the *primary* or rudimentary form of its four *fins*. But, since I maintain that this genus really belongs to the *Amphibia*, this name could not possibly apply to it, although that of *Protomelus* would be more characteristic, which signifies the *first* or *primary* form of the *limbs* or *legs*, from πρωτος and μελος; still, in preference to this last appellation, I propose the name of *Amphibichthys,* derived from αμφιβιος and ιχθυς, for this new genus; because it is, of all the *Amphibia,* that which retains the most fish-like or *ichthyic* characters, and is, in fact, intermediate between those two classes.

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* General Outline of the Animal Kingdom, p. 538.

† But Sir W. Jardine considers "the structure of the *nostril* as entirely analogous to that of the organ in Fishes: it is not a respiratory organ in *L. paradoxa*, the double opening is only similar to the valvular separation of the sac in Fishes."—See 'Remarks on the Structure and Habits of *L. annectens*' in the 'Annals and Mag. of Nat. Hist.' for March last, p. 26. This, however, is evidently a mistake, as will appear from the following "addition," which M. Bischoff has given to his paper in 'Annal. des Sci. Nat.,' Sept. Number, p. 155. "Again I add, on the subject of *nasal cavities*, on which so much has already been urged, that some weeks since, at my request, my father-in-law, M. Tiedemann, has likewise examined the nasal cavities of a very small specimen, and that he has found the canal to be in length 5½‴ (rhénales), proceeding obliquely at the back and on the outside, and opening into the cavity of the mouth. The species of Congers, on the contrary, which are found at Vienna, do not present any similar canal."

But it is necessary, for the reception of this new genus—a type also of a new family—in the Order III. *Manentibranchia* of my Branchial Classification, to divide it into *two* groups or *tribes,* because the gills in the *Amphibichthys* differ in being merely *fimbriæ* or fringes *concealed within* the branchial apertures like those in most Fishes, and are not *ramified* or *tufted,* and *externally* persistent, as in the *Siren* or *Proteus*; wherefore the former tribe I distinguish by the appellation of *Fimbribranchia,* and the latter by that of *Ramibranchia.*

Here, then, I subjoin my Classification of the *Amphibia* founded upon the *organs of respiration,* as modified and extended in the manner I have already explained.

Division I. VERTEBRATA.

Class IV. AMPHIBIA.

Sub-Class I. MONOPNEUMENA. Respiring singly, *either* by gills only, *or* by lungs alone.

Order I. Caducibranchia. Gills *decaying.*

Tribe I. Celatibranchia. Gill-fringes *concealed.*

Family I. *Cæciliadæ.* Body lengthened, slender, snake-like; skin smooth, wrinkled, mostly with minute scales; tail extremely short; legs none.

Genus: *Cæcilia.*

Tribe II. Prolatibranchia. Gill-tufts *exposed.*

Family I. *Ranidæ.* Adult body slender, oval; skin smooth or granulated; tail none; legs four; tongue long; teeth minute, fine; tympanum open.

Genera: *Rana, Ceratophrys, Hyla.*

Family II. *Bufonidæ.* Adult body short, roundish, thick, frog-like; skin tuberculated; tail wanting; legs four; tongue long; teeth none; tympanum open.

Genera: *Bufo, Rhinella, Otilopha.*

Family III. *Dactylethridæ.* Adult body short, sometimes oval, frog-like; skin smooth or tuberculated; tail none; legs four; tongue wanting or distinct; teeth minute or partly absent; tympanum hid.

Genera: *Dactylethra, Bombinator, Breviceps.*

Family IV. *Astrodactylidæ.* Adult body short, flat, frog-like, tailless; skin with tubercles; legs four; tongue wanting; teeth none; tympanum hid.

Genus: *Astrodactylus* (*Pipa*).

Family V. *Salamandridæ.* Adult body long, lizard-like; tail long, round or compressed; tympanum none; legs four.

Genera: *Salamandra, Salamandrina, Molge, Triton.*

Sub-class II. Diplopneumena. Respiring doubly, *both* by gills *and* lungs.

Order II. Imperfectibranchia. Gills *imperfect.*

Family I. *Menopomatidæ.* Body long, lizard-like; or lengthened, snake-like; with a tail; legs four; gill-like organs internal.

Genera: *Menopoma, Amphiuma.*

Order III. Manentibranchia. Gills *permanent.*

Tribe I. Ramibranchia. Gills *ramified* or *tufted.*

Family I. *Sirenidæ.* Body lengthened, snake-like, having a tail; legs two in front; gills tufted, external.

Genera: *Siren, Parvibranchus.*

Family II. *Proteidæ.* Body long, lizard-like, or fish-like, with a tail; legs four; gills ramified, external.

Genera: *Proteus, Menobranchus, Siredon.*

Tribe II. Fimbribranchia. Gills *fringed.*

Family I. *Amphibichthyidæ.* Body lengthened or long, fish-like, covered with scales, having a tail; dorsal and caudal membranes, resembling fins, strengthened by soft rays; legs four, rudimentary; gills fimbriated, internal.

Genus: *Amphibichthys* (*Lepidosiren*).

It is worthy of remark, that in comparing the gradual modifications in the organization presented by the different families in this very natural class, there will be found many singular resemblances even between the two extreme groups, the *Cæciliadæ* and the *Amphibichthyidæ*; inasmuch as they both possess scales, and the former seem to be furnished, in their young state, with the same kind of *fringed* gills, concealed within the branchial cavity, as the latter retain during the whole of life: and whilst, on the one hand, the *Cæciliadæ* are snake-like in their form and habits, they constitute the link between the class *Reptilia* and the class *Amphibia*; so, on the other hand, the fish-like shape and characters of the *Amphibichthyidæ* as clearly and gradually connect the class *Amphibia* with the class *Pisces*, both approximations being carried on in a most extraordinary and beautiful manner. And I have before noticed, that the order *Abranchia*, which had been previously formed for a certain *genus* in this class, cannot be applied to any *Amphibian*; for it is now well ascertained that every animal included in this class possesses, during one period of its existence at least, some *branchial* apparatus, which, with the retention of *lungs*, fully proves that these animals ought, according to their natural conformation, to be arranged in a *distinct* class, and not in a *mere* order of the class *Reptilia*. Wherefore the principal characters of the *three* latter classes of *Animalia Vertebrata,—Reptilia, Amphibia, Pisces,*—taken from their *organs of respiration,* are, membranaceous and cellular lungs without any gills for the *first* class; either gills in the early part of life, then cellular lungs in their adult state, or gills or some branchial apparatus, coexisting with cellular lungs through the whole of life, for the *second*; and gills only, without lungs, for the *third* class.

Norton House, Stockton-on-Tees, April 10th, 1841.